IF CHINA ATTEMPTED TO REUNIFY TAIWAN, WHAT WOULD THE REPERCUSSIONS TO EV SUPPLY CHAINS BE, AND HOW CAN STAKEHOLDERS PREPARE FOR THOSE REPERCUSSIONS?

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1. INTRODUCTION

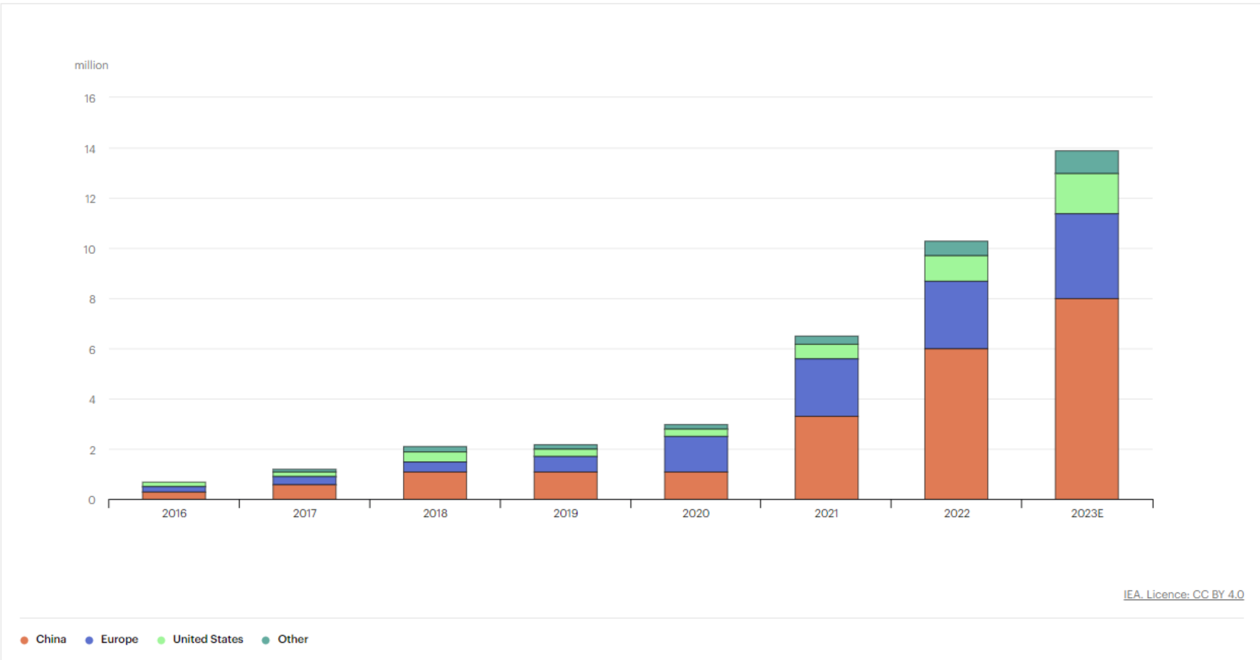
Electric vehicles (EVs) look set to replace Internal Combustion Engine Vehicles (ICEVs) in the not-too-distant future. However, there is a significant threat to this predicted trend; its supply chain's over-dependence on China and, to a lesser extent, Taiwan. One of the hottest geopolitical topics of today is the tension between China and Taiwan. This paper will explore the potential ramifications of a China-Taiwan crisis for the EV industry and how stakeholders, in the UK particularly, can prepare for that possibility.

2. BACKGROUND

2.1 The rise of electric vehicles

The electric car sales market has been growing exponentially in recent years. The share of electric cars in total new vehicle sales has more than tripled in three years, from around 4% in 2020 to 14% in 2022, with over 10 million electric cars sold in 2022[1].

Figure 2-1: EV sales by country of registration



Sources
IEA analysis based on EV Volumes.

Notes
2023 sales ("2023E") are estimated based on market trends through the first quarter of 2023.

Source: International Energy Agency (2023)[1]

Purchase costs are falling[2], whilst battery performance improvements and government policies, such as the UK government's commitment to phase out ICEV sales by 2030 (cars)[3] and 2040 (Heavy Goods Vehicles – HGVs)[4], have also contributed to growing demand.

With such pledges, the total global EV fleet is expected to grow to about 240 million vehicles by 2030 (over 10% of all road vehicles), representing an average annual growth rate of about 30%[5].

This trend is not limited to cars. Buses are the most electrified road segment, excluding two-/three-wheelers. Over 3% of buses were electric in 2022 and, if stated policies are met, this is expected to rise to 10% by 2030, at 2.7 million electric buses (e-buses)[5].

However, for these polices to be reliably pursued, a resilient supply chain is required[2]. At the moment, China's dominance of the EV supply chain means it is vulnerable to disruptions to its supply.

2.2 The electric vehicle supply chain

There are four broad stages to an EV supply chain, which is applicable to the different elements of an EV. For example, the EV battery supply chain involves[6]:

- **Upstream:** Mines extract rare earth metals for batteries, such as lithium and cobalt.
- **Midstream:** Processors and refiners purify the raw materials to create battery materials.
- **Downstream:** Battery manufacturers assemble battery cells into modules and sell them to automakers, who place them into EVs.
- **End of Life:** Reuse and recycling of batteries.

Figure 2-2: EV battery supply chain

Source: RMI (2023)[6]

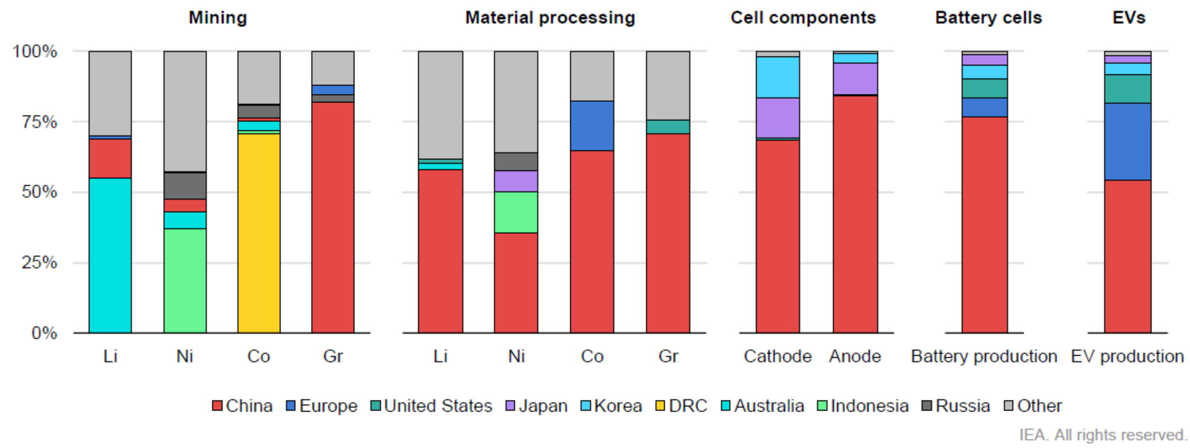
2.2.1 China's dominance of the electric vehicle supply chain

China is critical to the world's supply of EVs at every stage of the supply chain. The graph below from the International Energy Agency (IEA)[7] demonstrates the country's dominance of the EV battery supply chain, especially at the mid- and down-stream stages. China produced over three quarters of EV batteries, and over half of all finished electric vehicles in 2021[7].

The numbers are particularly staggering for e-buses. In 2021, China supplied more than 90% of the world's e-buses[8] and, in 2018, 99% of the world's e-bus fleet was operating in China[9][10].

Their influence of the upstream stage is also greater than it may appear at first, as it is not limited to graphite mining. Chinese companies own or finance 80% of the Democratic Republic of Congo's (DRC's) cobalt mines, which produce about 70% of the world's cobalt[11]; a metal commonly used in EV batteries[12]. Minerals are particularly important to EVs, with an electric car requiring six times the mineral inputs of its conventional counterpart[13].

Figure 2-3: Geographical distribution of the global EV battery supply chain



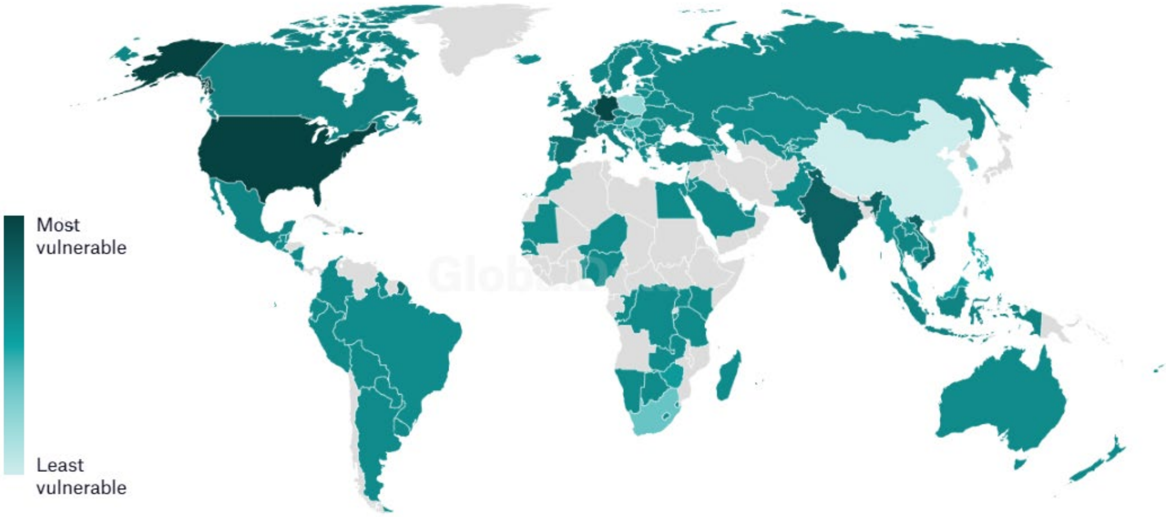
Notes: Li = lithium; Ni = nickel; Co = cobalt; Gr = graphite; DRC = Democratic Republic of Congo. Geographical breakdown refers to the country where the production occurs. Mining is based on production data. Material processing is based on refining production capacity data. Cell component production is based on cathode and anode material production capacity data. Battery cell production is based on battery cell production capacity data. EV production is based on EV production data. Although Indonesia produces around 40% of total nickel, little of this is currently used in the EV battery supply chain. The largest Class 1 battery-grade nickel producers are Russia, Canada and Australia.
Sources: IEA analysis based on: EV Volumes; US Geological Survey (2022); Benchmark Mineral Intelligence; Bloomberg NEF.

Source: IEA (2022)[7]

2.2.2 Implications of China's dominance for the EV market

China's dominance of the EV supply chain leaves other nations who are looking to increase their uptake of EVs in the coming years vulnerable to any disruptions their supply. The map below from GlobalData[14] represents the vulnerability of each country's supply chain; those with a hight trade deficit of EV battery materials are most vulnerable, whilst those with a high trade surplus are least vulnerable.

Figure 2-4: EV battery material supply chain vulnerability index (2022)



Source: GlobalData (2022)[14]

With the exception of China, all of the top ten countries in terms of EV registrations are amongst the most vulnerable in the world[14], as they rely heavily on imports to maintain their supply of EVs. This means that they do not have a strong domestic supply chain to fall back on, should their imports be disrupted.

Worst still, as shown earlier in this section, these imports are heavily reliant on just one source country; China. If there were a range of sources of these imports, production could be scaled up in other countries to make up for the disruption of one source. Without this option, any disruption could spell disaster for the industry.

2.3 Semiconductors' role in electric vehicles

Semiconductor is a term used interchangeably with microchips, as they both refer to the chips in electrical devices which require a semiconductor substance (e.g., silicon) to receive, process and store information[15][16][17]. Semiconductors range in size; the smaller the microchip, the more powerful and advanced it is. An average vehicle will mostly be using less-advanced, bigger microchips[18] for things like window motors.

As Figure 2-5 shows, there is currently not a lot of overlap between the advanced semiconductors and most vehicles. However, the more cars become equipped with complex infotainment systems and advanced driver-assistance systems (ADAS), the greater the requirement will be for more advanced semiconductors[19][20][21].

Figure 2-5: Overlap between EV semiconductor requirements and 5G and Internet of Things (IoT) advanced computing

A high amount of overlap exists between chips used for current technologies and those used for the auto industry, particularly for larger node size.

Overlap between trend and automotive nodes

	Electrification	**5G**	**IoT edge computing**
Leading edge Less than or equal to 28 nanometers (nm)	**Not applicable**	**Low overlap:** • Logic • Field programmable gate array • Application-specific integrated circuit	**Low overlap:** • Main processing unit • Memory
Trailing edge Greater than 28 nm	**High overlap:** • Discretes • Power management • Power supply units	**Medium overlap:** • Radio-frequency switches • Duplexer • Antenna	**Medium overlap:** • Sensor • Microcontroller • Analog (communication)

Source: McKinsey analysis

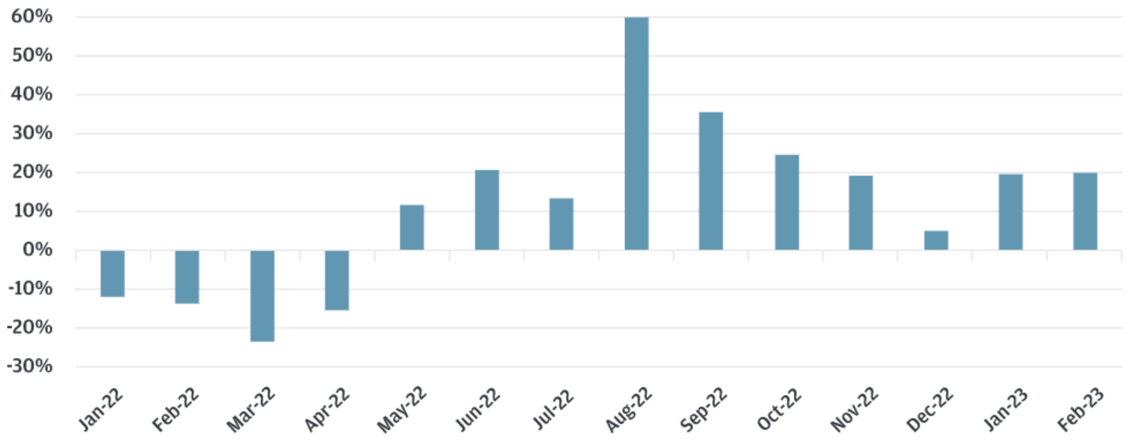
McKinsey & Company

Source: McKinsey & Company (2021)[18]

Electric cars require approximately twice as many semiconductors overall as their ICEV counterparts[22], and they may require up to 10 times as many semiconductors under 150nm[23]. This makes electric vehicles far more vulnerable to semiconductor supply chain disruptions than ICEVs.

We have already seen the impact the supply of semiconductors can have on the automotive industry as a whole. The microchip supply shortage of 2020-2022, rooted in COVID-19 restrictions and the Ukraine conflict[2021], compounded by auto manufacturers' "just in time" inventory strategy[20], meant that, at the height of the chip supply shortage, global auto production was down 26%. The industry only began to recover in mid-2022[21], in-line with microchip production recovery.

Figure 2-6: European auto production volumes in 2023 (year-on-year)



Source: J.P. Morgan

The J.P. Morgan production tracker monitors around 85% of European car production and indicates that volumes recovered by 20% year-over-year in January and February 2023, following continuous declines from August 2022.

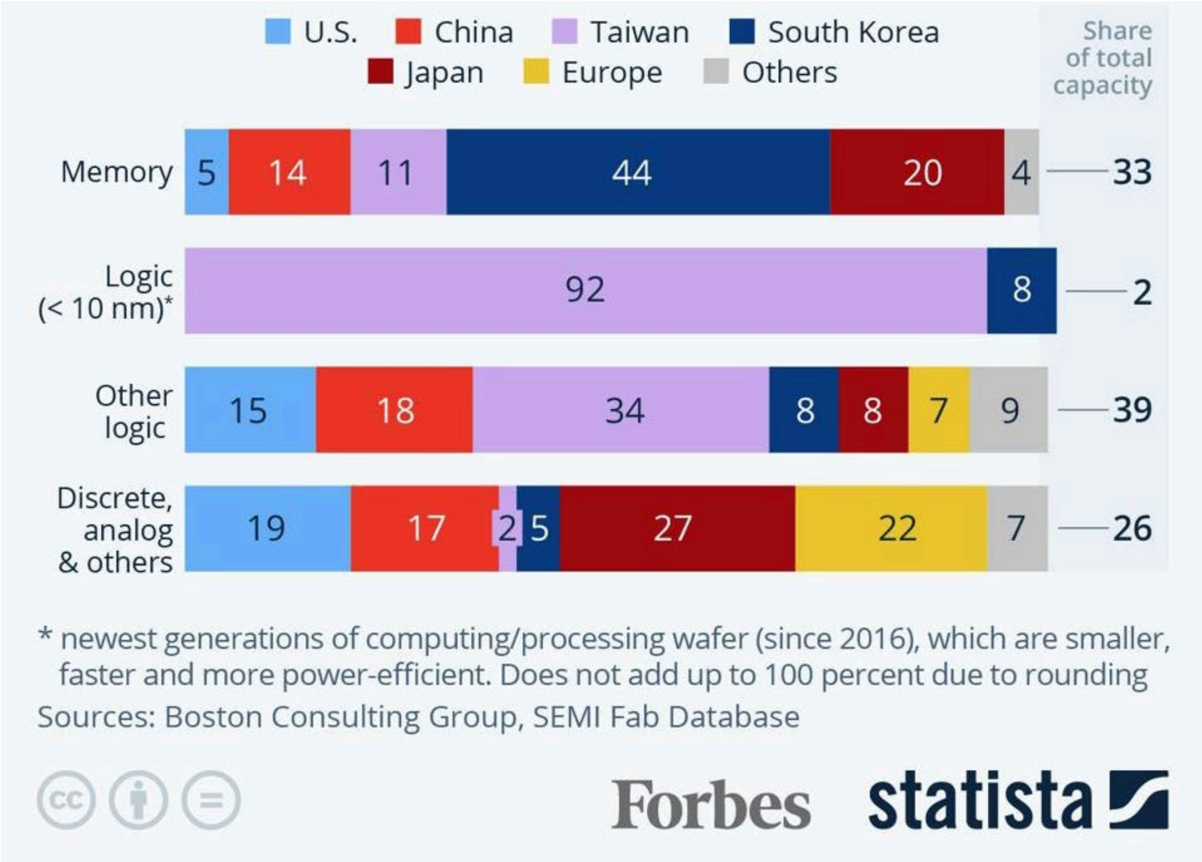
Source: J. P. Morgan (2023)[21]

So, whilst the transportation sector is not as vulnerable as sectors that are more dependent on more advanced semiconductors, it is also not immune to microchip supply constraints. This fragility is only likely to be exacerbated as demand for more advanced microchips steadily grows, particularly amongst EVs.

2.3.1 Taiwan's dominance of the semiconductor supply chain

Taiwan is *the* global superpower when it comes to semiconductor production. It is at the frontier of advanced semiconductors, producing 92% of the world's semiconductors with 10nm or less nodes, also known as logic semiconductors[22], whilst also leading the way in terms of research and development (R&D)[27]**Error! Bookmark not defined.**. And it's not just high-end microchips; over 60% of all the world's semiconductors are manufactured in Taiwan[24]. Most of these chips are made by the Taiwan Semiconductor Manufacturing Corporation (TSMC)[24]. Put simply, Taiwan is irreplaceable, in the short-term at least, when it comes to semiconductor production[25].

Figure 2-7: Share of global semiconductor wafer fabrication capacity, by type and location in 2019 (%)



Source: Forbes, Statista (2023)[22]

Again, whilst electric vehicles are less dependent upon the more advanced semiconductors than other industries, they are still heavily reliant upon semiconductors in general (more so than ICEVs) and are only going to become more reliant. This means the EV industry is still interconnected with Taiwan and would feel the effects of a disruption in Taiwanese semiconductor supply.

2.4 Brief overview of China-Taiwan tensions

This paper will not be able to cover the history behind the escalating tensions between China and Taiwan or the various geopolitical forces involved in depth. However, it is worth briefly explaining why there is a real possibility of a crisis, which ought to be prepared for.

Tensions between China and Taiwan have simmered since the end of the Chinese civil war in 1949, with the governments of each claiming to be the rulers of China as a whole. Taiwan has governed itself independently of China since then, but Beijing sees Taiwan as a rebel state of China which should be formally "reunified" with the mainland, using force if necessary[26].

These tensions have risen recently, partly due to Taiwan's current ruling party being pro-formal independence[26]. So, there is a political incentive for President Xi Jinping to want to "reunify" Taiwan.

But there is also strategic value to the island. Its semiconductor capabilities would be immensely valuable if China could control them, but it would also break the US's "first island chain" of allies from Japan to Malaysia, who allow the US to have a military presence skirting China. If this chain is broken, it would allow Chinese submarines easy access to the Pacific and undermining confidence amongst the US's other allies within the chain[27]. For these reasons, the US may be willing to use military force with China, made clear by recent statements[26] and military exercises with its allies. Whilst Taiwan holds less strategic significance for the UK, it has announced that it will be deploying a Royal Navy strike force to the region[28], so military action cannot be ruled out.

Figure 2-8: US First Island Chain

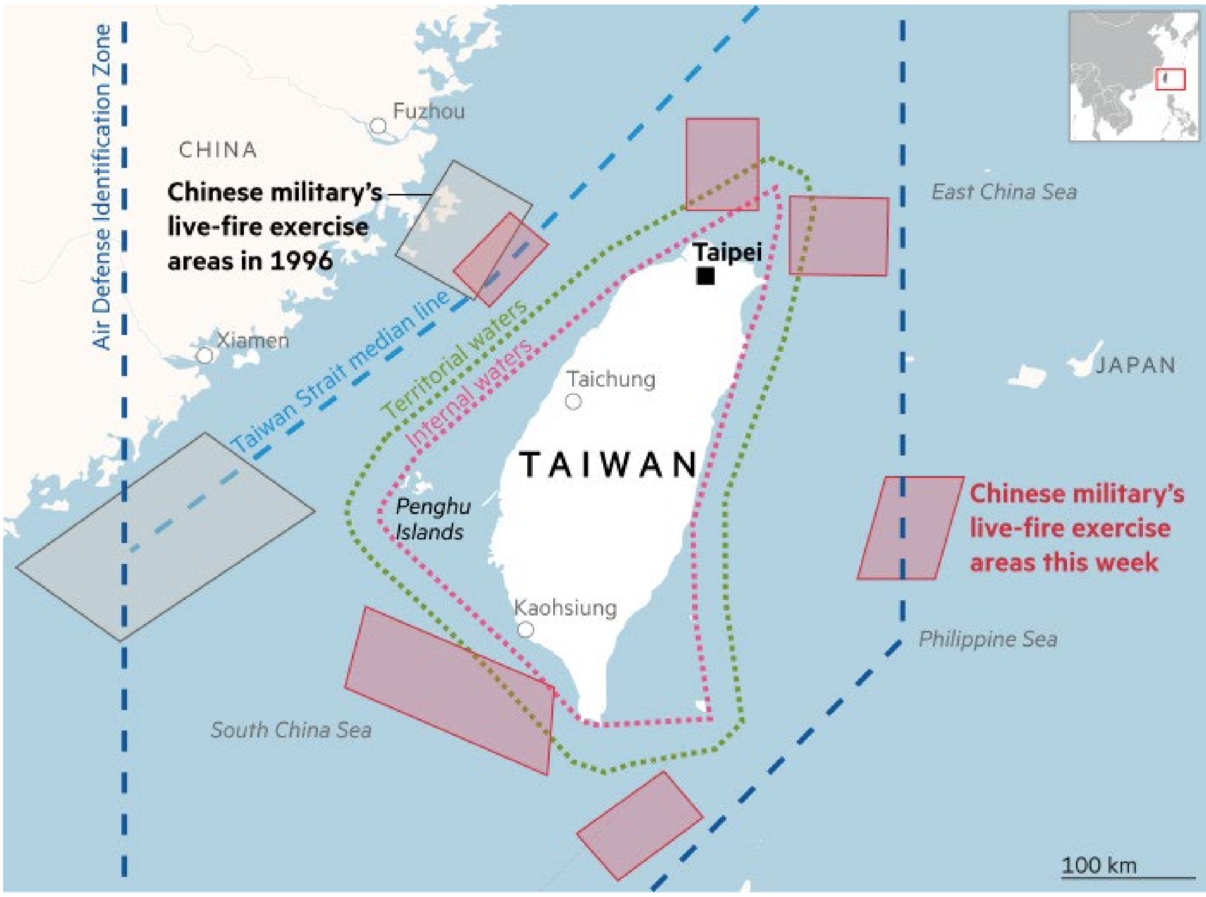
Source: BBC (2019)[29]

3. WHAT DOES THE FUTURE HOLD FOR CHINA AND TAIWAN?

This is an extremely complex and ever-evolving question with no definitive answers. The scope of this paper is not to analyse in detail the possible scenarios that might play out in the event of a China-Taiwan crisis. Instead, it will outline a range of likely actions and reactions, and the range of consequences this may have on the EV industry.

As explored above, it has become increasingly likely that China will attempt to "reunify" Taiwan at some point. With China's attempts to persuade the Taiwanese to voluntarily accept reunification through soft power and military intimidation so far being unsuccessful[30,31,32], this essentially leaves China only with further military escalation to achieve their goal[30].

Figure 3-1: A map of live-fire drills conducted by China around Taiwan in August 2022, possibly simulating a blockade



Source: Financial Times (2022)[33]

If a diplomatic solution cannot be found and China decides to escalate its use of force further to reunify the island, it has two main strategies to choose from, although one may lead to the other.

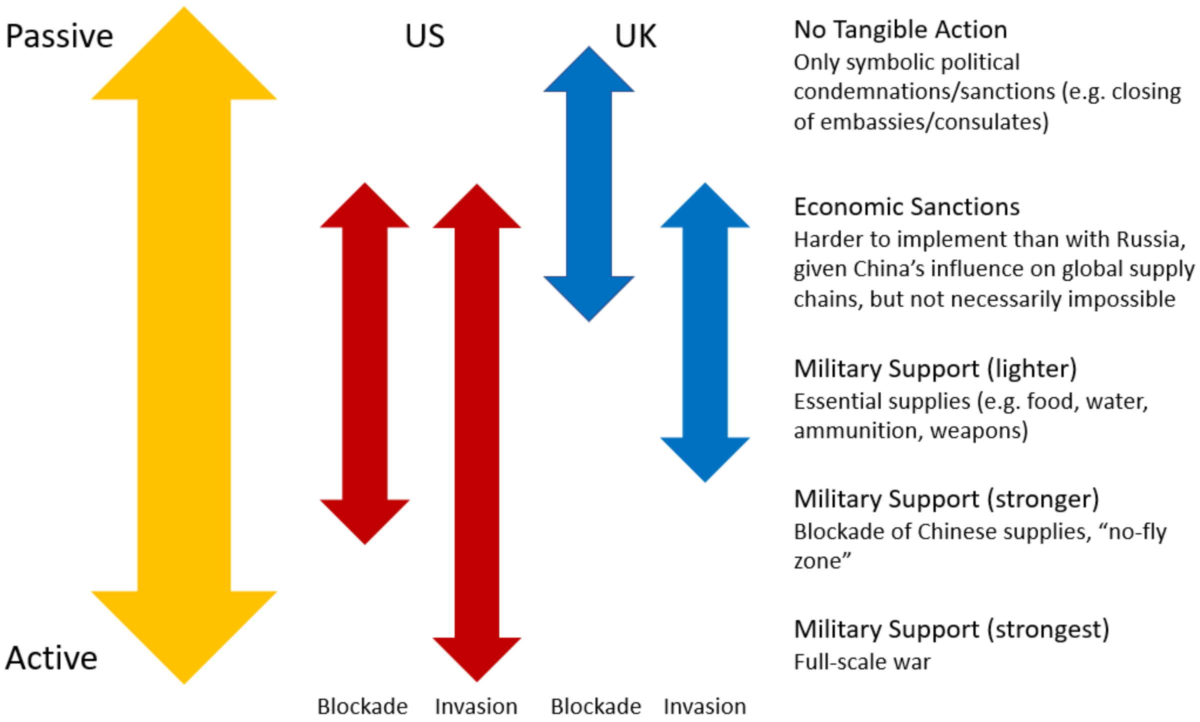
The first, and possibly more likely option[34], is an economic blockade of Taiwan via sea and air. This would probably be China's preferred escalation, as it is militarily, economically and politically less risky[31].

The second option is a military invasion of Taiwan. This would likely be preceded by a blockade of Taiwan to enhance its chances of success and to see if an invasion would be required at all.

3.1 What reactions would a blockade or an invasion draw from Taiwan's allies?

The spectrum of broad responses to a crisis is similar for a blockade and an invasion. However, as shown in Figure 3-2, the responses to a blockade are more likely to be on the passive end of the spectrum compared to responses to an invasion. Similarly, the UK's response in both scenarios is likely to be more passive than the US's, as Taiwan holds less strategic importance to it.

Figure 3-2: Likely spectrum of reactions to a China-Taiwan crisis for the US and UK



The level of impacts of a China-Taiwan crisis would broadly correlate to the severity of the crisis and the level of reaction of each country and their allies, although the whole world would be affected to some degree[37], even if no action was taken over the crisis. The duration of the crisis would also be impacted by Taiwan's allies' reactions, although this again would vary greatly on the actions taken.

3.2 Implications for the EV industry

In the event of an invasion of Taiwan, the impacts to the industry would almost certainly be more severe than a blockade-only scenario. Semiconductor supply would be severely affected in the short- to medium-term, even beyond the conclusion of the invasion (whatever that may be), as microchip factories would likely have been destroyed or damaged. Half of the world's container ships pass through the Strait of Taiwan [35], so shipments of EV parts and vehicles would also be disrupted by a crisis.

An invasion would make more active support from Taiwan's allies more likely. It's unclear whether this would lengthen or shorten the crisis in the short-term. The EV industry would hope it would shorten the crisis, as this would mean reduced short- to medium-term impacts. But more active support may result in worse long-term impacts if it meant China refused to trade with Taiwan's allies.

Figure 3-3: The Chinese People's Liberation Army practices an amphibious landing

Source: Business Insider (2021)[31]

It's hard to imagine a scenario in which the UK's, indeed the world's, EV industry isn't severely impacted by an invasion of Taiwan, given the dominance of China in this sector. The Office for Budget Responsibility predicts that 2% of the UK's GDP would be wiped off within four years, rising to 5.2% after 10 years[36]. At the moment, the UK's EV industry would be particularly vulnerable to these impacts, given its relatively weak domestic EV manufacturing capabilities[37].

In a blockade-only scenario, again the impacts would largely depend on the support of Taiwan's allies. However, as the reactions would likely be less confrontational, the impacts would also likely be less severe.

A blockade would still heavily impact semiconductor supply in the short-term, even if little to no support was provided to Taiwan. However, if a war could be avoided and microchip factories remained unharmed, the supply of microchips could bounce back relatively swiftly at the conclusion of the blockade, as has been witnessed recently[21].

If the US chose to blockade Chinese ships in retaliation, the supply of parts and vehicles from China, even if trade was not sanctioned, would also be heavily affected in the short-term. Again, the UK's level of support to Taiwan would determine the speed of recovery for its stakeholders once the blockade concluded.

Any economic sanctions imposed on trade with China could also have serious consequences for the EV industry, given the industry's current reliance on the nation. Again, the impact of sanctions would depend on their scale and form. However, probable impacts include, but are not limited to[19];

- Increased lead times for materials, batteries, and microchips;
- Increased metal and battery prices;
- Limited imports and exports from/to China; and
- EV manufacturer exits from China.

In short, there would be inevitable impacts to EV supply chains in the event of a China-Taiwan crisis, but the form, scale, and duration of these impacts would vary substantially depending on the type of crisis, the duration of the crisis, and the actions of Taiwan and its allies before, during and after the crisis.

4. WHAT CAN EV STAKEHOLDERS DO TO PREPARE FOR A POTENTIAL CHINA-TAIWAN CRISIS?

Whilst everything must be done to avoid a crisis over Taiwan, the possibility of a crisis is significant and should be prepared for accordingly. The options outlined in this section will have a UK-focus, given the audience of the TPM conference, but many of them will be relevant around the world due to the global dependence on China, and to a lesser extent Taiwan, at all points of the EV supply chain[7].

If the UK government does want the country to follow the global trend towards rapid EV adoption, it must ensure its EV supply chains are resilient to disruptions such as a China-Taiwan crisis. This means de-risking the UK's supply chains, rather than de-coupling completely from China and Taiwan; a line that Rishi Sunak recently used at a G7 summit in Japan[38], but has been employed extensively by CEOs and diplomats recently[39,40]. The phrase is used to emphasise that reducing dependence on China and Taiwan does not mean having to cease trading with either country altogether, nor should it.

In May 2023, the UK government announced its semiconductor strategy[41] and, in March of the same year, it updated its critical mineral strategy[42] (important for EV batteries). Both of these documents identified the fragility of the sectors' supply chains and outlined the steps required to de-risk supply chains and grow industries. Whilst industry stakeholders and experts agreed with the steps required to help the sectors, they were disappointed with the lack of definitive financial support and substantive plans to help the UK compete with the likes of the EU and US[37,43].

This section will outline the options to help de-risk UK EV supply chains and explore the ground that needs to be made up to its competitors.

4.1 Diversifying supply chains

Diversifying the UK's EV supply chains at all points is a key component to reducing dependence upon China and Taiwan. There are two interconnected aspects to this; boosting domestic manufacturing capabilities and better facilitating international trade.

4.1.1 Relatively weak domestic EV manufacturing

The UK is currently well behind the US and the EU in terms of its plans to scale-up battery production for electric vehicles. The Faraday Institute estimates that the UK could require 10 new gigafactories by 2040, each with a capacity of 20GWh[44], which dwarves the UK's current total capacity of 2GWh[37]. Whilst the EU has at least 30 new gigafactories planned or in construction, the UK has only one confirmed[37]. The demise of Britishvolt is also, in part, symptomatic of a lack of government support for gigafactories, with funding held back on condition of construction at its site beginning, which it never did[45]. The likes of France and Germany offer funds at a much earlier stage to help get factories off the ground, although it should also be noted mismanagement of Britishvolt did not help its cause[45].

Figure 4-1: 2031 projected battery production capacity based on announced projects (GWh)

Source: Benchmark Minerals (2022) cited in FT (2023)[45]

The UK is moving in the right direction but not quickly enough. The Automotive Transformation Fund (ATF) will make up to £850 million of funding available to R&D and industrialisation across the zero-emission supply chain[42] but McKinsey estimates the UK will need to make an investment of £5-18 billion by 2040 in battery manufacturing alone[46].

The UK has been struggling to attract private investment, partly due to the lack of upfront funding[37], but also in part due to concerns over post-Brexit trade deals. The Trade and Cooperation Agreement (TCA) stipulates a minimum percentage of domestic components for EVs to be traded tariff-free between the UK and EU, which are set to rise in the coming years unless renogatiated[37,47]. This has been, and still is, off-putting for private investors in UK EV manufacturing and will need to be addressed if the UK is to secure critical private investment.

Local and regional governments also have a role to play in this. The French region of Hauts-de-France has spent more than €200m, supported by huge national subsidies, to secure battery manufacturing investment from a Taiwanese battery maker ProLogium[48].

It's a similar story when it comes to semiconductors. The UK's £1bn semiconductor strategy is completely outmatched by the US and EU, who have announced funding plans closer to $50 billion[43].

4.1.2 What can be done?

If private investment can be attracted through more supportive financing and trade deals, there are plenty of market opportunities the UK could explore.

One opportunity which looks particularly promising is a proposed gigafactory in Somerset for Jaguar-Land Rover's owners, Tata, which looks to be at an advanced stage of talks over incentives with the UK government[49]. The firm is believed to be requesting £500 million in subsidies to locate to the site in the UK rather than Spain[50], due to higher energy costs and the other challenges of operating in the UK explored above. This is a golden opportunity for the UK and one that ought to be grasped.

Source: Andrew Boyers, Getty[49]

But the UK's battery manufacturing requirements will not be met by one plant; further investment opportunities need to be explored. South Korea's "Big Three" (LG Chem, SK Innovation and Samsung SDI), which supply 26% of the world's EV batteries, currently do not benefit from the US' Inflation Reduction Act's (IRA) incentives[51]. However, this may be reviewed by the US as they look to de-risk their supply chains, so this opportunity ought to be investigated promptly to attract investment from these companies to the UK's shores.

There are also many emerging players on the EV battery manufacturing scene. Many countries, such as Indonesia, India and Thailand, have announced ambitious industrial strategies to scale-up local battery production[52]. There may be less competition to strike deals with some of these countries, although there will be more risk attached and longer to wait whilst factories are set up, without the proven track-records and already-operational factories of the established battery manufacturers.

Looking further up the supply chain, the UK might wish to strengthen its existing relationship with Australia, given its lithium mining outputs. The metal is in most electric vehicle batteries[53] and Australia is currently responsible for roughly half of the world's supply[54]. However, lithium reserves are actually far larger in Chile, Argentina, and Bolivia[54], so partnerships with these countries will be very desirable in the coming years, as they look to increase their output. Cobalt is also found in the waste of copper mining in Australia, so there is another opportunity for mineral extraction. With that said, the battery industry appears to be moving away from cobalt, as explored later.

The UK government seems to have identified it would be too costly to effectively build up a mass-production semiconductor industry domestically from scratch, instead opting to concentrate on R&D[4143]. This may well be a pragmatic approach to take but it must be supported by more secure supplies from volume-producing nations; something the current strategy lacks in detail. For instance, the semiconductor partnership announced with Japan has only so far confirmed a £2 million joint R&D fund[55]. This needs to be built on quickly to secure imports of large volumes of semiconductors into the future.

In summary, improving international trade through a combination of upfront state investment, trade deals and an improved regulatory environment to encourage greater private investment will help to secure domestic supply in the long-term. But improved trade with established EV battery and semiconductor manufacturers is also required to ensure supply in the short-term.

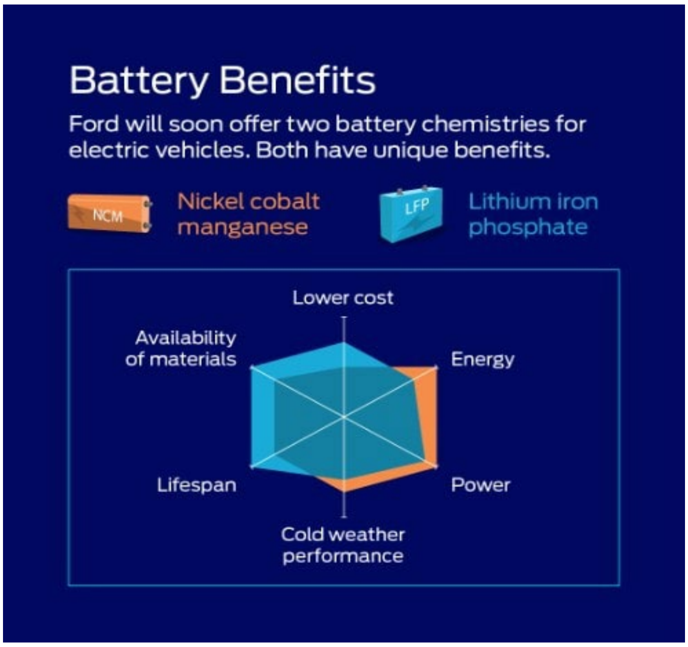
4.2 Shortening supply chains

Private companies have taken matters into their own hands to secure their supply chains in some instances. Tesla has made deals with Australian graphite miners, Syrah Resources, and US nickel suppliers, Talon Metals[14], to provide it directly with the metals for its batteries. Meanwhile, General Motors has developed a battery which requires 70% less cobalt[14] to lessen its reliance on Chinese supplies. This may be an option for UK-based vehicle manufacturers, such as Jaguar-Land Rover, and the UK government may be able to facilitate these sorts of deals in return for private investment in manufacturing plants in the UK.

4.3 Battery technologies

The EV industry has proven its ability to quickly adapt to supply chain challenges with its recent adoption of new battery technologies, partly to reduce its dependence on cobalt, although cost reduction is a significant motivation. Most lithium-ion batteries, the most common type of EV battery[53], use cobalt[56], a very expensive metal which is mostly supplied by China, in their nickel cobalt manganese (NCM) cathodes. However, lithium iron phosphate (LFP) cathodes, which negate the need for cobalt, have rapidly increased in popularity in recent years, not least because they are cheaper than their NCM counterparts.

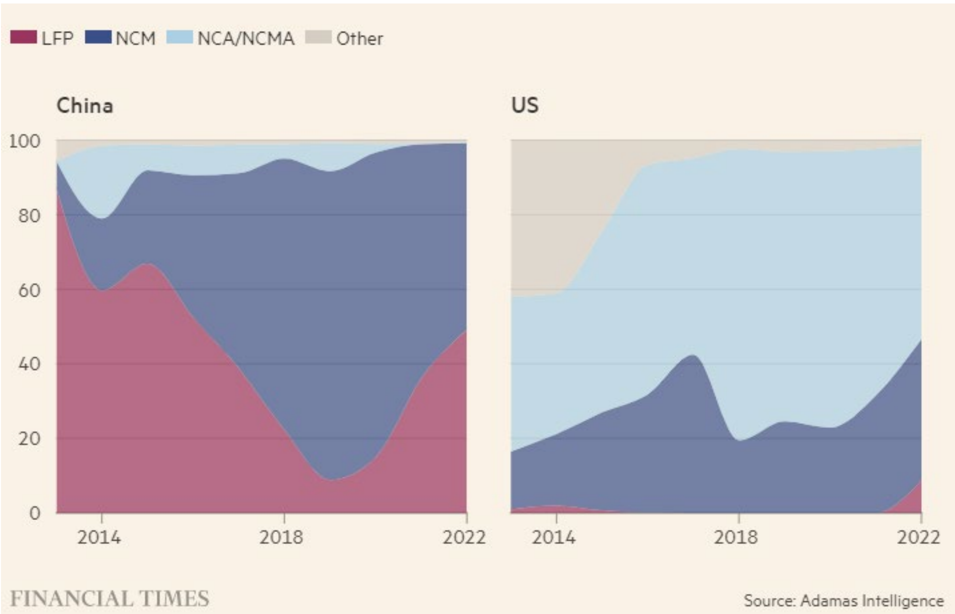
Figure 4-2: Cathode comparison



Source: Ford (2023)[57]

Whilst LFP batteries do not have the range of NCM batteries, their advantages over NCM batteries mean they are actually most popular in China, even though the supply of cobalt is of no concern for its market. In 2022, LFP batteries accounted for about half of EV batteries deployed in China[58]. Other markets are expected to follow in China's steps in rapidly adopting this new technology in the coming years[5358], especially after a recent breakthrough technology (lithium iron manganese phosphate – LFMP) appears to have doubled the range of an EV battery and is set to enter mass production in 2024[59].

Figure 4-3: Market share of battery capacity deployed, by cell chemistry (%)



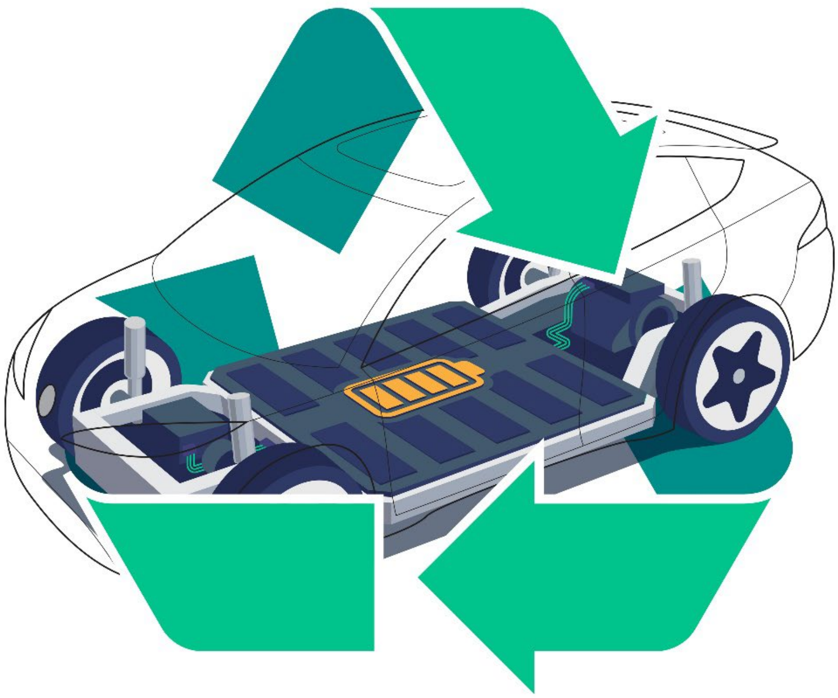
Source: Adams Intelligence cited in Financial Times (2023)[58]

Whilst it seems private vehicle and battery manufacturers are already moving towards LFP, the UK and/or local governments could consider minimum requirements and/or incentives for LFP production in new gigafactories to accelerate uptake and reduce reliance on cobalt. Although, the UK ought to lean on carrots, rather than sticks, as it tries to attract investors for battery plants and catch up with its counterparts.

Battery technology is constantly evolving, with new technologies partly being aimed at reducing dependency on certain critical minerals[53], which may partly secure supply chains. But this cannot be relied upon as the only solution to de-risking supply chains, as all critical minerals are finite and have their drawbacks, and they only reduce dependence on China if other countries scale up their production of new batteries, fast.

4.4 Improving recycling capabilities

A key issue with electric vehicles is their need for finite, critical minerals for their batteries. Other than supply chain security concerns, their scarcity means their price can be very high but also volatile[58], child labour is involved in the mining of some (e.g. cobalt[56]), and there are serious, permanent environmental scars left by their mining. There are clear incentives, then, to develop large-scale used battery recycling plants, to reduce the requirement for raw mineral extraction.



Creator: Peter Varga | Credit: petovarga - stock.adobe.com

This is a medium- to long-term option, as there won't be enough EVs coming to the end of their life to satisfy their growing demand for some time to come[53]. Whilst this is unfortunate in the short-term for the reasons listed above, this does give stakeholders time to invest in R&D to create more efficient processes and to find the investment required for large-scale recycling facilities. It's thought that 38% of the carbon emissions and 35% of the cost of producing electric batteries could be cut by recycling instead of mining minerals[60]. In the context of this essay, it can also reduce the reliance on other nations for raw materials for batteries. If efficient cobalt and graphite recycling processes can be found, in particular, this could help to reduce supply chain overdependence on China.

Once again, Chinese companies are leading in this area, with over 70% of the world's EV battery recycling capacity[60], and the US is using its IRA to try to catch up[53], whilst the UK is some way behind[60]. Redwood Materials won a $2bn loan from the US government to support the construction of a new plant in Nevada earlier in 2023[53]. Whilst in the UK, Altilium, a leader in the R&D space domestically, has been granted a comparatively small £3m by the government to set up a small facility to help prove the concept to attract large-scale investment[60].

This may be a smart move by the UK government. Invest in creating the best technology before committing large sums of money. However, given the inevitable importance of battery recycling in the coming years, the UK can ill afford to be left behind, as they have been with gigafactories. More investment is required in domestic commercial-scale battery recycling to avoid becoming dependent upon China for this as well.

4.5 Reduce reliance on private transport

This is a topic for many essays over in its own right. But, whilst the above options have answered the question, "what can be done to reduce dependence on China and Taiwan for EVs?", should the question instead be, "what can be done to reduce dependence on EVs and, by extension, private vehicles?"? Whilst certainly they come with benefits over ICEVs, EVs do not solve some issues, like congestion, if they simply replace ICEVs in the same or greater quantities. Not only that, but supply chain concerns are also just one of a number of issues associated with EVs, some of which are outlined above.

As the UK sits at the foot of a steep hill towards mass EV adoption, there is a unique opportunity to challenge the "continuity" approach of merely swapping fuel cells in private vehicles; addressing some issues but leaving many unanswered and introducing a whole new set of challenges. Would the enormous sums of investment required to get an EV manufacturing industry off the ground in the UK be better spent enhancing existing public and active transport networks? Given the challenges outlined above, it seems quite likely, and certainly an option that should be sincerely explored, rather than simply following the option which looks most like the current transport picture.

But, just like de-risking supply chains, the answer to these questions doesn't have to mean rejecting EVs completely. For instance, e-buses can form part of public transport expansion plans.

The future of motorised movement is electric. The degree to which movement is powered by private vehicles is yet to be decided.

5. CONCLUSION

The potential for a China-Taiwan crisis holds a clear, and possibly imminent, threat to the EV supply chain, given the industry's over-dependence on both countries, and their neighbours, for raw materials, components and completed vehicles at all points of the supply chain. The exact scale, duration or form of the impacts is hard to predict, as the actions of the various parties involved could range greatly. It's likely that the more serious and lengthier the crisis is, the more damaging it will be to the EV industry. But it's almost certain that any sort of crisis would result in a degree of disruption in the short-term, at least.

The possibility of a China-Taiwan crisis is just one of many vulnerabilities of the supply of EVs, mostly caused by an over-reliance on a small number of producing nations. Many of these issues could be solved through de-risking supply chains or reducing reliance on electric vehicles, or private vehicles in general.

There are a number of opportunities to de-risk supply chains, which should be explored in tandem, and involve cooperation between public and private stakeholders. For the UK, the most important action is to diversify its supply chain, through an interconnected strategy of bolstering its domestic manufacturing capabilities and improved international trade. The latter of which can help the former to help grow from a relatively weak starting point to secure supply in the medium- to long-term but is also important in ensuring short-term supply. This could be supported by shortening supply chains, investing in new battery technologies, and improving domestic recycling capabilities.

Before those options are pursued, however, a decision needs to be made on the future of people's movement. Many of the issues surrounding supply chain vulnerabilities, and issues that are not tackled by EVs, like congestion, could be addressed by discouraging and reducing the need for private vehicles altogether. Like the de-risking of supply chains, this does not mean moving away from EVs completely; rather reducing the total number of vehicles required to move the population.

Footnote

Word count: 4,999 *(excluding figure titles and sources)*

It should be noted that this topic is constantly evolving. Pertinent new information, articles and strategies were released as this paper was written almost on a daily basis. This paper has provided an overview of the topic with as up-to-date information as possible, but there will no doubt have been developments since its completion.

This paper aimed to remain impartial and provide neutral forecasts and suggestions. However, these are directed primarily at countries heavily reliant on EV imports from China, as they are likely to be most affected by disruptions to these supplies, as outlined above. For the purposes of brevity required for this paper and the nature of the TPM audience, there is a particular focus on UK stakeholders.

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